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Manual dexterity and successful hearing aid use

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Abstract

Fine dexterity of the hand might be expected to correlate with the successful use of a hearing aid. In this study, the manual dexterity of 30 individuals between 65 and 85 years using a hearing aid was tested by the Purdue pegboard test and the result was compared to the benefit obtained from the use of a hearing aid assessed by a questionnaire. Of the 30 individuals included in this study 16 were wearing a 'behind the ear' type of hearing aid and the rest had an 'in the ear' type of hearing aid. A comparison is made between the two types of heariing aids. The results demonstrate a correlation between manual dexterity and successful use of a hearing aid when all the 30 individuals were considered as a single group. However, no such correlation was found for 'in the ear' group when they were analysed separately.

Key words: Hearing Aids, Laterality

Introduction

The assessment of manual dexterity is used in rehabilitation to evaluate hand function. This study aimed to assess whether manual dexterity is a significant factor in determining successful hearing aid use. If such a correlation exists it could be an important factor to be considered during rehabilitation of the hearing impaired who use hearing aids. The study also compared the effects of manual dexterity on the two different types of hearing aids, 'in the ear' and 'behind the ear' that are being prescribed and fitted at Torbay Hospital, Torquay.

Manual dexterity depends on a sustained and rapid transfer of sensorimotor information between the cerebral cortex and cervical spinal cord. These corticospinal channels have multiple interconnections in the cortex and spinal cord which allow cross-talk between the channels and enable very rapid transfer of information needed for any sophisticated use of the hand. The probable cortical areas are area number four, anterior cingulate, post-arcuate, parietal and the insular cortex.[1] Manual dexterity also depends on the functions of the cerebellum and the integrity of the peripheral nerves and muscles of the upper limb.

Several tests have been developed to assess manual dexterity. These include the Purdue pegboard test which measures fine finger dexterity. This test is simple to perform and has a high level of test/re-test reliability.[2] Hence the Purdue pegboard test was chosen to determine manual dexterity in our study.

Assessment of the success of hearing aid use is problematic. A variety of methods using defined sets of subjective responses to carefully structured questions have been devised.[3–5] These correlate with communication status and highlights specific areas of difficulty. In our study we have made use of the questionnaire devised by Brooks[5] with some modifications. This questionnaire assesses two important aspects of aided performance. They are (1) the level of satisfaction attained and (2) the self-rated performance of the instrument. Satisfaction is assessed by asking for a rating on a 10 point scale ranging from total dissatisfaction to complete satisfaction. In order to assess the performance, individuals are given five different situations and are asked to rate the performance on a five-point scale in each instance. A hearing aid success score is derived by adding the satisfaction score to the performance score. Significant correlation is expected between these two aspects of hearing aid use.

Fine dexterity of the hand might be expected to correlate with successful hearing aid use.[6] However, a literature search failed to show any other study that demonstrated such a correlation. It is also assumed that the smaller 'in the ear' type hearing aid requires finer dexterity to adjust and handle compared to the bigger 'behind the ear' type.

Methods and materials

We performed our study on 30 individuals selected at random from among patients who had been wearing a hearing aid for six or more months. The

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TABLE I

COMPARISON OF ITE AND BTE GROUP IN TERMS OF AGE, GENDER AND HEARING IMPAIRMENT AND DURATION OF HEARING AID USE

			Both groups together	ITE	BTE
Age in years	–	Mean	75.16	75.5	74.87
		SD	7.57	6.83	8.37
Sex	–	Males	22	11	11
	–	females	8	3	5
Hearing loss*	–	Mean	43.04	42.85	43.20
		SD	6.7	7.61	6.03
Duration of hearing aid use in years	–	Mean	5.7	5.5	5.87
		SD	3.6	3.2	4.01

*Mean of 0.5 Hz, 1 kHz, 2 kHz, 4 kHz and 8 kHz air conduction threshold for both ears.
ITE = in the ear; BTE = behind the ear.

demographic details of the study group are shown in Table I. Sixteen of these patients were wearing the 'behind the ear' type hearing aid and the rest were wearing the 'in the ear' type of hearing aid. The mean duration of use of the hearing aid was found to be 5.7 years (SD = 3.6) when all the 30 subjects were taken into account. The mean length of hearing aid use was found to be shorter for the group with the 'in the ear' type of hearing aid (mean 5.5 years, SD = 3.2) compared to the one with the 'behind the ear' type of hearing aid (mean 5.87 years, SD = 4.01) ($p = 0.3$).

In our hospital both types of hearing aid were available and individuals who had specifically requested a smaller hearing aid were fitted with the 'in the ear' type of hearing aid and the others were fitted with a 'behind the ear' type of hearing aid. No other factors were taken into consideration when selecting the type of the hearing aid. Candidates were seen when they attended the out-patients clinics of ENT or audiology. One of the authors made himself available for a particular session every week to carry out this investigation. Every individual with a hearing aid attending the audiology/ENT out-patient clinics on that particular session were approached to find out their willingness to participate in this study. All those who were willing to participate were then given a detailed explanation regarding their role in this study. An information leaflet was also provided and written consent was obtained as per the direction of the local ethical committee. All the candidates were then interviewed, their case notes were examined and a physical examination was carried out to find out whether they fitted within the criteria chosen for inclusion for this study. The first 30 candidates who met the inclusion criteria were selected for the study, however, it was noted that quite a substantial number of the candidates examined did not meet the inclusion criteria.

In order to reduce the discrepancies due to variables to a minimum the following groups of persons were excluded from the study: (1) persons above 85 and below 65 years, male or female; (2) Individuals with hearing worse than 70 dB and better than 30 dB on average and those with asymmetrical hearing loss. A difference of more than 10 dB in the pure tone average threshold for air conduction between the ears is defined as asymmetrical loss. The average is calculated for five frequencies i.e. 500 Hz, 1 kHz, 2 kHz, 4 kHz and 8 kHz; (3) persons with aided or unaided visual acuity less than 4.5/6; (4) persons with co-morbid conditions that could possibly affect manual dexterity; (5) persons with functional handicap (e.g. mentally retarded); (6) those on medication which could affect the functions of the neuro-muscular system; and (7) individuals wearing more than one hearing aid.

All the candidates in the study were initially tested for manual dexterity for right and left hand separately and then both hands together using the Purdue pegboard test, to derive a score that was recorded. The Purdue pegboard test was originally designed to aid in the selection of adults for jobs requiring manual skills.[7] The test consists of a wooden board with two centred rows each with 25 small holes drilled in them and reservoirs for pins, collars and washers across the top. There are two subsets. In the first, the person being tested is required to put the metal pins into the holes as fast as they can after some practice. The number of pins inserted in 30 seconds are counted and the best of three trial gives the score. In the second subtest, the assembly task, the testee is required to place a washer, a collar and a second washer on the pin once it is in position. The score is the number of pins assembled in 30 seconds. Each completed assembly is equal to four points. The score is the best performance amongst three trials. The procedure was repeated three times and only the best of these three scores was included in the study. A questionnaire then was given to the candidates to assess the successful use of the hearing aid (Appendix). This questionnaire was originally developed by Brooks in 1989.[5] In order to make it more user friendly, we have modified the format of the questionnaire as suggested by the local research development and support unit. To improve the compliance, the questionnaire was shortened by deleting questions that were of less relevance to this study.

Only two aspects of the hearing aid benefits were evaluated, the self-rated performance and satisfaction. To assess performance the maximum possible score was set at 25. Five questions relating to the performance were asked with five possible answers for each question. The scoring pattern was such that an answer of 'very good' carried five points and an answer of 'useless' carried one point. Whenever there was doubt in indicating a particular answer, the lower of the two scores was taken as the most probable one. Satisfaction was assessed on a 10 point scale ranging from total dissatisfaction to complete satisfaction. Total dissatisfaction carried one mark and complete satisfaction carried 10 marks. This particular questionnaire was used as it was shown to be fairly consistent with a second questionnaire given after a definite interval.[5] The same author has also noticed that when using this questionnaire, evaluation of benefit obtained by a hearing-impaired individual from a hearing aid could be assessed subjectively with an acceptable degree of reliability. The amount of daily use was also recorded, as the amount of use of the hearing aid could be related to the performance and satisfaction. The hearing aid success score was obtained by adding the performance score to the satisfaction score, the maximum possible score being 35.

Tactile sensitivity is another factor that could affect manual dexterity. It is expected that tactile sensitivity declines in parallel with manual dexterity. The Purdue pegboard test assesses fine finger dexterity that indirectly assesses tactile sensitivity. Hence in this study no attempt was made to measure tactile sensitivity separately.

Results

The average age of the individuals included in this study was 75.16 years. Twenty-two of them were males and eight were females. Twenty-six were right-handed and all of them except two were using a right-sided hearing aid. Four were left-handed and three of them were using a left-sided hearing aid. The mean manual dexterity score and hearing aid success score of right-handed persons wearing a right-sided hearing aid was found to be 41.26 and 27.4 respectively. The average manual dexterity score of left-handed individuals wearing a left-sided hearing aid was 52 and their hearing aid success score was 25.3. Only three candidates were wearing a hearing aid on the side opposite to that of their dominant hand and their mean manual dexterity score and hearing aid success score was found to be 42.33 and 28.66 respectively. No one included in this study claimed to be ambidextrous.

TABLE II

SUMMARY STATISTICS (ALL 30 PATIENTS)

	Mean	Median	Standard deviation
Manual dexterity	45.3	45.5	9.24
Hearing aid success score	26.4	26.0	4.52
Hearing aid performance score	18.4	19.0	3.64
Satisfaction score	8.03	8.00	1.47

When males and females were assessed separately, no significant difference was noted in the manual dexterity score (males: mean = 45.09, SD = 9.96; females, mean = 45.75, SD = 10.6). It is interesting to note that men have a better hearing aid success score (mean 27.04, SD = 4.76) than women (mean = 24.62, SD = 5.06) despite having a low manual dexterity score.

Table II gives summary statistics for the various measures for all 30 patients. Patients using the two types of hearing aid 'in the ear' and 'behind the ear' were compared for manual dexterity, hearing aid success, hearing aid performance and satisfaction using Student's *t*-test. The results are presented in Table III. There was evidence of a difference in the means for both manual dexterity ($p = 0.01$) and for the hearing aid success score ($p = 0.049$). In both cases, the higher mean was found for the 'in the ear' group. As manual dexterity and the success score are correlated (Table IV), it is obviously possible that the difference in the mean success score is due to the difference in manual dexterity score. In order to investigate this a simple adjusted success score was calculated by dividing the success score by the manual dexterity score for each patient. A comparison of the two groups for this adjusted success score showed no evidence of difference ($p = 0.64$). This supports the suggestion that the difference in the success score is due primarily to a difference in manual dexterity.

Correlation between various measures were assessed using Pearson's correlation coefficient (Table IV). There was a large positive correlation

TABLE III

SUMMARY STATISTICS AND T-TESTS FOR COMPARING GROUPS

	'In the ear' group Mean (SD)	'Behind the ear' group Mean (SD)	*p*-value
Manual dexterity	49.6 (8.44)	41.3 (8.31)	0.01
Hearing aid success score	28.1 (2.89)	24.9 (5.22)	0.049
Adjusted success score	0.582 (0.102)	0.603 (0.135)	0.64
Hearing aid performance score	19.6 (2.41)	17.3 (4.22)	0.06
Satisfaction score	8.43 (1.16)	7.69 (1.66)	0.17

TABLE IV

CORRELATION (ALL 30 PATIENTS)

	Manual dexterity
Hearing aid success score	0.555 ($p < 0.01$)
Hearing aid performance score	0.602 ($p < 0.001$)
Satisfaction score	0.802 ($p < 0.001$)

TABLE V

CORRELATION BETWEEN MANUAL DEXTERITY AND HEARING AID SUCCESS SCORE (EACH GROUP SEPARATELY)

Group	Correlation
'In the ear' type	0.283 ($p > 0.10$)
'Behind the ear type'	0.574 ($p = 0.02$)

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between manual dexterity and satisfaction ($r = 0.8$) and between hearing aid performance and satisfaction ($r = 0.78$). There was also positive correlation between manual dexterity and success ($r = 0.56$) and performance ($r = 0.60$). Looking at the two hearing aid types separately, there is a significant positive correlation between manual dexterity and success for the 'behind the ear' ($r = 0.57$) but not for the, 'in the ear' type (Table V).

All the 16 individuals fitted with the 'behind the ear' type of hearing aid were wearing hearing aids everyday. But only 10 out of 14 fitted with the 'in the ear' type of hearing aid were making use of the hearing aid everyday and the rest were using it on most days.

Discussion

A significant proportion of new hearing aid fittings are rejected by elderly patients and one of the suggested reasons for this is their inability to fit the ear mould and hearing aid correctly.[8] It is expected that fine dexterity plays a significant role in adjusting and fitting hearing aids and that individuals with finer movements of the hands will benefit more from the use of these aids compared with less dextrous individuals. This study is planned to test this hypothesis.

A search of the literature failed to show any study designed to demonstrate a correlation between manual dexterity and successful hearing aid use although Murlow *et al.*[6] developed a logistic regression prediction model for hearing aid benefit on more than 80 individuals and noted that manual dexterity was one of the many factors which may influence the successful use of a hearing aid.

Analysis of the results of all the 30 patients together showed a significant correlation between the manual dexterity score and hearing aid success score. But when separate analyses were carried out for the two different types of hearing aids, such a correlation was shown only for 'behind the ear' hearing aids. It was interesting to note that there was no correlation between manual dexterity and hearing aid success in individuals wearing 'in the ear' hearing aids. This finding was in contrast to our expectation. A study by Upfold *et al.*[9] showed that on average, an 'in the ear' aid was statistically easier to use than either the 'behind the ear' or 'in the canal' types. The same author has noted that the 'in the ear' aid was easier to turn on and turn off compared with to the 'behind the ear' aid. The advantage of the 'in the ear' hearing aid is that it has only one, rather than two, parts to fit. Hence it is possible that individuals with poor manual dexterity may find it easier to use an 'in the ear' type of hearing aid compared to a two part 'behind the ear' type of aid. This suggests that manual dexterity is less likely to influence the benefit obtained from hearing aid use in individuals wearing 'in the ear' aids compared to those wearing 'behind the ear' aids. This could explain the absence of correlation between the manual dexterity score and hearing aid success score in 'in the ear' aids as shown in our study.

Smaller hearing aids (e.g. in the canal) were found to be superior to the 'behind the ear' type as regards to time of use and operational difficulties.[10] In another study by Jerlvall *et al.*[11] it was found that the hearing aid users preferred the 'in the ear' type to the 'behind the ear' for several reasons including ease of fitting. On the other hand Turk[12] reported preference of the 'behind the ear' type to the 'in the ear' by the experienced users. In our study the difference in the mean length of hearing aid use between the two groups was found to be small and insignificant suggesting that neither of the groups had the advantage of being more 'experienced'.

Fitting hearing aids on the same side as the dominant hand was not found to be an advantage. However, in this study the total number of patients was too small for statistical analysis. In one study it was noted that the majority of patients with handling problems with the hearing aid were over 75.[8] In our study 12 persons were above 75 years of age. However, their mean hearing aid success score was found to be higher than their younger counterparts despite having a low mean manual dexterity score. Meredith and Stephens[8] have noted that females over 75 are more likely to encounter hearing aid problems of one kind or another than are male or younger counterparts. However, in our study no significant difference was noted either in the manual dexterity score or in the hearing aid success score between the two sexes.

The observations from this study suggest that manual dexterity is a factor to be considered when deciding the type of hearing aid to be prescribed. Those individuals with poorer dexterity may be better off with an 'in the ear' hearing aid than a 'behind the ear' aid. However age, sex and handedness may be of little value in selecting the type of hearing aid.

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Appendix

HEARING AND ASSESSMENT QUESTIONNAIRE

Thank you for answering this questionnaire.

Do you use your hearing aid ....
(please tick the most appropriate answer)

(1) Every day ❑
(2) Most days ❑
(3) Some days ❑
(4) Occasionally ❑
(5) Not at all ❑

In the following situation how do you rate the hearing aid?

1) In person to person conversation

Very Good ❑
Good ❑
Average ❑
Poor ❑
Useless ❑

2) In a group of family or friends at home

Very Good ❑
Good ❑
Average ❑
Poor ❑
Useless ❑

3) Listening to music

Very Good ❑
Good ❑
Average ❑
Poor ❑
Useless

4) Listening to TV or Radio

Very Good ❑
Good ❑
Average ❑
Poor ❑
Useless ❑

5) With a group of people in noisy conditions

Very Good ❑
Good ❑
Average ❑
Poor ❑
Useless ❑

Please try to assess your satisfaction with the hearing aid on a 10 point scale.

(This is a visual analogue scale. Mark at 10 if you are completely satisfied with the hearing aid, similarly at 1, if you are not at all happy. Mark in between according to your satisfaction)

Totally satisfied 1---2---3---4---5---6---7---8---9---10 Completely dissatisfied

Please indicate whether you experience any of the following:

(1) Difficulty in inserting aid
(2) Difficulty in manipulating aid
(3) Unwanted noises

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